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ANALYSIS OF TWO REPORTS ON MORTGAGE RATE INSURANCE

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Introduction

The purpose of this report is to analyze two recent reports which were prepared for the Canada Mortgage and Housing Corporation. The first report entitled Mortgage Rate Insurance: Overview, Risk Management, and Pricing was prepared by Professors George Gau and Dennis Capozza of the Faculty of Commerce at the University of British Columbia and is dated June 1982. The second report entitled, Canada Mortgage and Housing Corporation, Mortgage Rate Insurance was prepared by Arthur Anderson and Co. and is dated February 1983. It will be convenient to refer to these reports as Report A and Report B and it is assumed that the reader is familiar with both of them.

The present writer was requested to conduct a critical analysis of both these reports in terms of their theoretical soundness and practical relevance. They deal with the introduction of mortgage rate insurance in Canada. This insurance would protect property owners from interest rate increases when their mortgages are renewed. Report A examines the theoretical basis for such insurance and explores methods whereby the insurer can reduce its exposure to investment risk. Report B uses the concepts developed in Report A to simulate the operation of a particular form of mortgage rate insurance during the period 1976 until 1982 using actual market data. Thus Report B relies heavily on the approach developed in Report A.

The format of the present report is as follows. First Report A will be analyzed under various headings as follows: overview and general impressions, assumptions and methodology and detailed comments. Second Report B will be analyzed using a similar framework. Third some general observations concerning future research activity in this area will be made.

Report A Overview and General Impressions

The authors of this report pose the problem clearly and develop a solution which is innovative. However, in my opinion, the assumptions they use and the models they employ are sometimes totally inappropriate. Unfortunately, these defects lie at the theoretical foundations of their structural model and I would not recommend that mortgage rate insurance be introduced based on the material presented here. It so happens that there are more sophisticated and suitable models available in the literature than those used by the authors and it would prove instructive to employ these models rather than the ones used in the Report.

Report A Assumptions and Methodology

It is necessary to give a brief outline of the method proposed in the Report in order to comment on specific aspects of it. The authors note that an insurer which sells mortgage rate insurance has sold a particular type of put option. The mortgage renewal date corresponds to the maturity of the option. If interest rates--ie. mortgage interest

rates--have risen above a certain level on renewal then a prespecified amount is payable to the insured. Thus as interest rates rise the insurance becomes more valuable and the insurer is facing a larger claim. To protect the insurer the authors recommend investment in an asset whose value increases with interest rate rises. An example of such a strategy would involve the selling short of futures contracts involving long term debt instruments. Ideally these futures contracts should involve mortgages of the same term and type as those insured but in practice it may be possible to use some other instrument whose value is a function of long term interest rates. Assuming that the underlying option has been correctly modelled it is possible to compute the requisite amount of mortgages (if there was an appropriate market for them) to be shorted. A further adjustment is required if no such market exists and some surrogate instrument needs to be used. Option pricing theory can also be invoked to compute equilibrium values or fair values of the premiums to be charged for this type of insurance. Here again it is very important to have an adequate model for the underlying stochastic state variables (in this case the long term rate of interest).

Perhaps the most serious criticism of Report A is that the underlying option pricing model is inappropriate. The authors used the Black-Scholes classic model which was developed for stock options and which assumes that the underlying asset (ie. the common stock) followed a lognormal

diffusion process. While this assumption is mathematically convenient it is inappropriate for valuing options on assets whose values depend on interest rate levels. First a stochastic model for interest rates should be used. There are a number of these in the literature and the model suggested by Brennan and Schwartz (1980) is a possible candidate. In particular the Brennan-Schwartz model assumes that both the long term interest rate and the short term interest rate vary in a stochastic and inter-related fashion. On the other hand Report A assumes that short term rates are constant and that long term rates vary stochastically in a rather specialized fashion. Neither of these assumptions is correct. Furthermore there is a relationship between short term interest rates and long term rates. There are other more specific points concerning the model used in Report A that will be covered in the next Section of this report.

Another important area of concern is the treatment of the insurers' interest rate risk. Report A suggests that this risk be dealt with by selling short futures contracts denominated in United States dollars in the United States. I have some concerns about this aspect of the proposal (some of which are mentioned in the report itself). First it assumes that historical relationships between U.S. and Canadian interest rates will persist in the future. Second there is exchange rate risk which although it can be hedged through other financial instruments would in certain circumstances be dangerous. Third the yields on U.S. G.N.M.A.

mortgage futures are not determined by precisely the same factors that govern mortgage interest rates in Canada and there could be divergencies. Fourth the question of an arm of the Canadian government taking such a very large position in a U.S. market raises a number of policy issues many of which have political implications. In fairness to the authors they point out that it would be preferable to hedge the risk within Canada. I do not think the associated risks of using the U.S. market are sufficiently highlighted. Again more comprehensive and detailed research would be needed on this aspect of the proposal.

Report A Detailed Comments

In this segment of my report I will present detailed comments. For convenience I will connect these to the relevant sections of Report A.

Chapter 1 Overview

This is in general well written, clear and well documented. The authors present a good case for mortgage rate insurance.

The section on the role for government needs to be expanded. The authors suggest that there is a catastrophic risk which cannot be covered in the early years. This provides an implicit subsidy to property owners presumably from taxes paid by the population as a whole. The present writer is not experienced in this field but suggests that the whole policy issue needs much more critical examination.

Page 9. The comments about portfolio insurance associated with life insurance contracts do not convey an accurate picture. Contracts with these guarantees have been a real source of concern to insurance companies in many jurisdictions. A number of studies have looked at the feasibility of hedging these guarantees (Boyle & Schwartz (1977), Brennan & Schwartz (1980), Collins (1982)). As far as the United Kingdom is concerned it is my understanding that many insurers no longer issue these maturity guarantees--as they are called--because of the associated liabilities.

Chapter 2

This chapter deals with the management of the interest rate risk exposure using the U.S. futures markets. Some simulations are carried out which illustrate that the insurer would have earned a profit over the periods considered. It is important to emphasize that the years 1976-1982 were characterized by rising interest rates and a weakening Canadian dollar. It is not clear that similar results would have been obtained for other scenarios.

Page 53 et seq.

The tests of hedging effectiveness must be viewed with considerable caution. In many cases the R^2 values are low. Furthermore the future relationships may differ radically from those experienced during the last 6 years which was unique in many ways.

It is interesting to note that when Canadian financial futures were used the closest association was between Canadian mortgages and Canadian treasury Bill Futures illustrating again the correlation between long term and short term rates--a relationship not captured in the model used by the authors later in their Report.

Chapter 3 Option Pricing

As mentioned earlier it is my belief that the option pricing model used in this chapter is seriously flawed for the purpose at hand. The model specified on page 81 of the paper is basically the classic Black-Scholes model introducing a modification made by Merton. Instead of the model postulated by the authors a model which reflects the stochastic characteristics of long term and short term interest rates should be used.

It is not clear from formula (2) on page 81 how the fact that mortgage repayments include both interest and principal is taken into account. It would appear that only interest payments are included but the exposition is unclear on this point.

Since the option pricing model used is inappropriate the premiums and hedge rates obtained from it will be unreliable.

The figures computed in Tables 3-1 to 3-3 have not all been checked by me but they appear to follow from the assumptions. It is not clear what value of Γ the short term

interest rate has been used to derive these numbers.

Page 86. It is suggested that changes in volatility in the stock market causes problems which have been resolved by traders in stock options. I would contend that volatility changes are still a big problem even in the stock option market and that the issue is largely unresolved.

Page 86. The standard deviation calculations need more discussion and analysis. First the volatilities are unstable. Second the model used by the authors uses the standard deviation of mortgage values. No explicit translation of interest rate variability into mortgage values is given. There is a difference between assuming that interest rates are lognormal and assuming that mortgage values are lognormal. The Report does not deal with this point--at least--explicitly.

Page 88-89. If hedges are rebalanced at discrete intervals they will not be riskless. This point has been discussed in the case of stock options by Boyle and Emanuel (1980). Furthermore the distribution of hedge returns is not in general symmetrical. This point could be developed in conjunction with a more realistic option pricing model.

Page 89. It would also be instructive to have a more detailed analysis of the composite hedge (equation (7.)). This should be carried out using a realistic model. It may be necessary to modify equation (7) but I have not pursued this point.

Page 90. It is far from clear that the hedged portfolio is riskless in the present context of discrete rebalancing, transaction costs and cross hedges.

Tests for lognormality - Appendix page 91

It is not clear what tests have been employed. Since the mortgage rates refer to overlapping time periods there is auto-correlation and this violates the assumption that the successive monthly values should be independent. I have problems with this entire appendix because the authors have not explained in detail what they did. The appendix ends with the following comment "reserves should be carried to protect against unexpected losses from this source." How much reserves?

Report B General Impressions and Overview

Since the empirical simulations here are based on the analysis of Report A any weaknesses in Report A will also be carried over to Report B. I have already pointed out the serious theoretical flaws in the models used in Report A.

Report B contains a lengthy set of Tables reflecting empirical simulations of various phases of mortgage rate insurance based on the analysis and methodology of the earlier report. The general conclusion is that mortgage rate insurance is a viable and profitable operation. I think the Report extrapolates too much from one specialized time period. It offers little by way of intuitive explanation for

the results obtained and at times is very unclear as to what the underlying assumptions and methodologies being employed actually are. It would be desirable to conduct a similar analysis over different scenarios since the results might well be different from the rosy picture presented here.

Report B Specific Comments

For convenience I refer to the page numbers in Report B for these comments.

Page 1. The penultimate paragraph points to a dichotomy between the method proposed for this report and the option-pricing approach favoured by the authors of Report A. If an option-pricing approach is adopted then the amount of the premium is the initial estimate of the current value of the insurer's liability. As time passes the value of the option can be found using an option-pricing approach. Report B seems to be using a probability distribution of future interest rates to compute expected claims and by discounting these back arrive at appropriate reserves. This is the classical actuarial approach which is inappropriate for risks which are stochastically dependent.

Page 1. Section 2

The report uses NHA mortgages. Note from Table 3.4 in Report A that NHA mortgages have significantly lower volatilities than other mortgages. To the extent that non-NHA mortgage holders would use this insurance the results are not relevant.

Page 2. Simulation Results

Exact details on how the premiums were obtained are not given. Have they been determined using the option framework of Report A or some sort of discounted expected value?

Page 3. (A) Cumulative Results

The Report notes that for certain deductible ranges the insurance is unprofitable for the insurer. This would reflect one of the flaws mentioned earlier. Table II highlights this point. If the majority of insureds opted for a 5 year mortgage term with a deductible of at least 1.5% there could be serious deficiencies.

Page 3. Individual Policy Reserves

Since the 78 one year term policies involve a great deal of overlapping periods these are not independent tests.

Page 4. If interest rates oscillate periodically around the insured rate this would lead to transactions tests being generated on a continual basis. It is not clear to me how monitoring the Plan as mentioned in the Report will mitigate this risk.

Page 6. I have no idea where the distribution of future mortgage interest rates comes from or how it is obtained. References and background calculations should be given. Such a distribution must surely be a conditional distribution in

the sense that it depends on current mortgage rates. This approach reflects a naive and dated approach to stochastic interest rate behaviour. Furthermore it is inconsistent with the (erroneous) assumption of Report A that interest rates are log-normally distributed.

Page 7 and 8. The Sample MRI Plan Transactions

While the discussion is for the most part clear some of the numbers appear to be incorrect. The monthly mortgage payment on a $50,000 mortgage with a 25-year amortization period at 15% is $623.07. In the same vein I compute that a $50,000 mortgage which is being amortized over 25 years will have an outstanding principal amount of $48,534.07 after 5 years have elapsed. There are other incorrect figures in the example. While it is often convenient to use rounded numbers I cannot justify these inaccuracies on this basis.

Page 9. It is stated here that the premiums used were supplied by the authors of Report A. No clear indication of how the premiums were computed is given. If a Black-Scholes approach was employed then the variance rate used has not been given.

Page 10. (D) Investment Strategy

Why was it necessary to assume that the mortgage insurance premium was invested at 2% below the prevailing mortgage rate. Why not use actual rates on short term money available in the market. Furthermore if margin calls required the insurer

to borrow this borrowing rate could also have been set realistically at a market rate.

General Point

The analysis and interpretation of the results obtained is not sufficiently penetrating. To what extent the excess reserves are due to the unique time period and to fortuitous model mis-specification is not clear.

Future Research Activity and Directions

These are some preliminary observations on the current status of mortgage rate insurance. The concept is an innovative one and it would be of considerable interest to develop an approach using a more appropriate interest rate model and incorporate some of the suggestions mentioned in the present report. It would also be helpful to pool the ideas and suggestions generated by other well-qualified experts who have an interest in and a knowledge of their area. The question of risk-hedging using the U.S. market is troublesome. Recently an options market has developed in Canadian long term bonds and these instruments would provide the necessary hedging requirements. There may be less need for government involvement given this development although the market is still relatively thin. However the existence of these instruments means that an individual can carry out the hedging exercise himself by purchasing a put option. If interest rates rise then the increase in the value of the put can offset

the additional payment on the mortgage. Although this would not be a perfect hedge in terms of maturity profile or instrument type it seems to offer attractive possibilities. Furthermore it would present a market-based solution with no subsidy from government.

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